

wherein $n = 1 - 5$;

- B) homopolymers of monomers having structure (I) or (III) or (IV);
- C) copolymers of monomers having structure (I) or (III) or (IV).

REMARKS

Claims 1-23 are pending. Claims 8-15 have been withdrawn from consideration as being directed to non-elected subject matter. Claims 1-7 and 17-23 are rejected. Claim 2 is cancelled and claims 1 and 3 amended. Support for the amendments can be found throughout the application, for instance at pages 10-11 and 15 (lines 22-23) of the specification and in the claims as originally filed. No new matter is added. Claims 1, 3-7 and 16-23 are submitted for further consideration at this time. Applicants respectfully request reconsideration and withdrawal of all rejections.

Claim Rejections - 35 U.S.C. 112

Claims 1-7 and 17-23 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite. It is alleged in the Office Action that in claim 1, the phrase "porosity in the range 5-500 nm" is unclear. Applicants respectfully disagree. With reference to the page 1402 of the Webster's Unabridged Dictionary, 2nd Edition (attached), it is clearly seen that the term "porosity" means "a pore". Accordingly, the term "porosity" as set forth in claim 1 seems clear and proper in the context of the claimed present. Nevertheless, the

application also clearly states that pore size is determined by an atomic force electronic microscope (See page 15, lines 22-23 of the specification), and therefore, claim 1 is amended as indicated herein to refer to "pore size", in order to advance prosecution. Applicants point out that the sentence spanning pages 10 and 11 of the specification states that "[s]uch porosity is remarkably higher than the porosity of the prior art perfluorinated dense membranes, which only have a porosity of chemical-structural type, with pore size of about some Angstrom (about 10, see the comparative Examples)". Clearly, the term "porosity" is the equivalent to the term "pore" as used in the claimed invention.

It is further alleged that claim 2 is redundant. Applicants respectfully note that this point is moot as claim 2 is cancelled as indicated herein.

It is also alleged that certain portions of claim 3 are unclear. However, Applicants respectfully point out that claim 3 is amended as indicated herein to recite "selected from the group consisting of A), B) and C)", as is suggested in the Office Action, so as to set forth clear Markush language. Claim 3 is also amended as indicated herein to recite "polymers made of monomers selected from the following:" and "dioxoles having structure (I):", so as to clarify that section A) of claim 1 is concerned with polymers made of monomers selected from the following: (I), (II), (III), (IV).

Finally, Applicants note that it is alleged in the Office Action that there is insufficient antecedent basis for the term "dioxole" in claim 5. Yet, Applicants respectfully point out that the amendment of claim 3 to refer to "dioxoles having structure (I):" make clear the existence of adequate antecedent basis for all terms of claim 5.

Applicants therefore urge that all claims are clear and definite.

Claim Rejections - 35 U.S.C. 103

Claims 1, 2, 3, 7, 18-20 and 22 are rejected under 35 U.S.C. 103(a) as being obvious over Banerjee (U.S. Patent No. 5,795,668).

Applicants respectfully disagree. The present invention in a preferred embodiment is concerned with the technical problem of producing films made of (per)fluorinated amorphous polymers that may be used for separation processes having improved porosity, and obtainable by less expensive industrial processes.

The present invention in a preferred embodiment is therefore concerned with porous membranes of (per)fluorinated amorphous polymers having a pore size in the range 5 - 500 nm, determined by an atomic force electronic microscope. Also, 80% - 90% of the pores have a size ranging from minus 5 nm to plus 5 nm of the value of the distribution maximum peak.

As noted throughout the application, the porous membranes of the present invention may be prepared by a process of: a) preparation at room temperature of a solution of amorphous polymer in a fluorinated solvent, the solution having a viscosity between 5 - 5,000 cP at 23°C; b) spreading of the solution on an inert support; and c) solvent evaporation at a constant temperature, generally at between 10°C-40°C, preferably at a temperature lower than 10°C-45°C with respect to the solvent boiling temperature, for a period from 1 to 10 days (See e.g., page 9, line 19 to page 10, line 20).

Applicants also note that Example 5 (comparative) of the application demonstrates that where a membrane is prepared by layering with a stratifying knife a polymer solution on a support, and then the deposited polymer is dipped in a coagulation bath of a non-solvent to obtain an asymmetric membrane according to the prior art, the

properties with respect to permeability and gas selectivity are completely different from those of the membranes of the claimed invention (See e.g. Table 2). Clearly, the pore size distribution is different in the claimed invention and the process conditions noted above are critical in obtaining the claimed membrane.

No such invention is taught or suggested in the prior art. Applicants address several allegations set forth in the Office Action. It is alleged that the Banerjee reference discloses a method of coating a support and reducing the pores of the support by coating a polymer solution, then drying the coated solution. However, Applicants would like to point out that the methods disclosed by Banerjee are not methods primarily addressed to coating a support. Instead, Banerjee is concerned with methods for preparing a porous support (col. 8, lines 38-40).

It is also alleged in the Office Action that the application discloses a similar composition and process as in Banerjee. However, with respect to compositions, Applicants would like to point out that according to Banerjee, both amorphous polymers and crystalline polymers (e.g., PTFE) can be used in the compositions (See col. 5, lines 18-20 and 43-44). In contrast, the membranes of the present invention are prepared with only amorphous polymers. Banerjee simply does not teach or suggest that amorphous polymers can be used to prepare membranes with improved properties as claimed. Moreover, regarding processes for preparing a porous support as disclosed by Banerjee (col. 7, line 37 to col. 8, line 12), Applicants note the following. Banerjee discloses the mixing of fluorine containing polymer with a pore-forming agent, forming the polymer into a film, followed by the extraction and removal of the pore-forming agent (col. 7, lines 37-43). Applicants point out, however, that this process is quite different from any process used to obtain the claimed porous membranes, since Banerjee includes a pore-forming agent that

remains in the formed film. Indeed, as noted, an extraction step must be performed to remove the agent. It is noted that this process implies that the pore-forming agent does not form a solution with the polymer, otherwise the formation of the film in the presence of the agent could not be explained. In fact, extraction of the agent follows film formation, as noted above. Yet, concerning processes for obtaining the claimed invention, it is to be noted that the polymer should form a solution with the solvent. The solution has a viscosity within the claimed range. The solution is then slowly evaporated under those conditions of the present invention. Such process features are simply not taught or suggested by any process of the Banerjee reference. Applicants urge that since such process features are not taught or suggested, the processes of Banerjee are unsuitable for obtaining a porous membrane as claimed, and thus the disclosure of Banerjee must be seen as failing to teach or suggest the claimed invention.

Banerjee also discloses forming a mixture of fluorine polymer, preferably non-sintered polytetrafluoroethylene, and a liquid lubricant (e.g., kerosene or fluorine oil) into a membrane by extrusion or rolling, followed by a monoaxial or multiaxial stretching treatment (col. 7, lines 45-50). This process is also quite different from any process used to obtain the claimed porous membranes, in that Banerjee teaches a solution of the polymer, not its mixture with a liquid lubricant. Moreover, the processes for obtaining a porous membrane as claimed involve neither an extrusion step nor a subsequent monoaxial or multiaxial treatment. In sum, such process as disclosed by Banerjee is unsuitable for obtaining the porous membranes of the claimed invention.

Banerjee further discloses (a) contacting PTFE with a fluid that penetrates and swells, at a temperature of about 250°-400°C; (b) cooling and separating the penetrated, swollen polymer from unabsorbed fluid; and (c) removing the absorbed fluid to

form a porous film (col. 7, lines 53-63). Applicants urge that this process is also irrelevant for obtaining a porous membrane as claimed. Applicants note that this process uses PTFE, which is insoluble in any solvent, whether inorganic or organic. In sum, none of the processes disclosed by Banerjee teach or suggest any solution of polymer in a fluorinated solvent, as needed for obtaining the claimed porous membranes. In that the processes of Banerjee are unsuitable for obtaining porous membranes as claimed, the rejection should be withdrawn.

Finally, it is alleged in the Office Action that it would have been obvious to produce membranes with pores as claimed by controlling the amount of polymer in the perfluoropolymer composition, since the pore coating on the microporous support depends on solution viscosity. It is further alleged that the reduction in porosity of the support, or the porosity of the final membrane, can be predicted from the final pore size, and thus the reduction of pore volume from the initial 50-95% to 80-90% is within the skill of the art. It is noted that the Patent Office appears to be of the opinion that according to the present invention, pore formation occurs by applying the perfluoropolymer composition to the microporous support and pore reduction in the microporous support. However, any such opinion has no basis, as it is seen in Example 1 that according to the present invention a membrane is prepared on a glass support, and then the membrane is characterized for average pore size and pore distribution (See page 15, lines 16-23 of the specification). It is to be noted that the membrane was analyzed as such, without considering any attached microporous support. Indeed, the membrane of the claimed invention possesses its improved properties independent from any properties of the microporous support. As seen from Example 1, the membrane of the claimed invention shows a pore distribution wherein 80-90% of the pores have a size ranging from ± 5 nm of the value of the distribution

maximum peak. In fact, the pore average size was 34 nm and about 90% of the pores have sizes in the range 30-38 nm. Accordingly, the size ranges from ± 5 nm of the value of the distribution maximum peak.

Applicants also note that somewhat confusing is the allegation that depending on the composition of the polymer solution, the reduction of pore volume from the initial 50-95% to 80-90% should be within the knowledge of those of ordinary skill in the art. Applicants point out that the range of 50-95% is apparently drawn from col. 7 (line 7) of Banerjee, which refers to the porosity of the porous support. Indeed, porosity as defined by Banerjee is a ratio of the volume occupied by pores to the entire volume of the porous material (col. 7, lines 13-15). Yet, the range of 80-90% in the claimed invention refers to the percentage of pores having a size ranging from ± 5 nm of the value of the distribution maximum peak. Accordingly, it should be clear that the range of 80-90% is not a reduction of pore volume, but the % of pores in the claimed membrane having an average size that is ± 5 nm of the value of the distribution maximum peak. In other words, the 50-95% porosity of the microporous support of Banerjee is irrelevant to the claimed invention. Applicants urge that the rejection should be withdrawn.

In view of the amendments and remarks above, Applicants submit that this application is in condition for allowance and request favorable action thereon.

In the event this paper is not considered to be timely filed, Applicants hereby petition for an appropriate extension of time. The fee for this extension may be charged to our Deposit Account No. 01-2300. The Commissioner is hereby authorized to charge any fee deficiency or credit any overpayment associated with this communication to Deposit Account No. 01-2300, referencing Attorney Docket No. 108910-00006.

Respectfully submitted,

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Enclosures: Marked-Up Copy of Claim Amendments
Webster's New Universal Unabridged Dictionary (p. 1402)

MARKED-UP COPY OF CLAIM AMENDMENTS

Claim 1 (Amended). Porous membranes of (per)fluorinated amorphous polymers having a [porosity] pore size in the range 5 - 500 nm, determined by an atomic force electronic microscope, wherein 80% - 90% of the pores have a size ranging from minus 5 nm to plus 5 nm of the value of the distribution maximum peak.

Claim 3 (Amended). Porous membranes of (per)fluorinated amorphous polymers according to claim 1, the (per)fluorinated polymers selected from the group consisting of A), B) and C):

A) polymers [of one or more monomers having structure (II)] made of monomers selected from the following:



wherein: Y_1 and Y_2 are selected from F, Cl, CF_3 , OR_f

wherein R_f is a C_1 - C_5 perfluoroalkyl radical;

[with one or more comonomers having the following structures:]

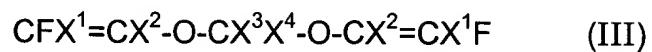
dioxoles having structure (I):



wherein: Z is selected from F, R_f , OR_f ; R_f is a perfluoroalkyl

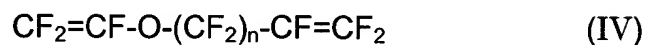
radical C_1 - C_5 ; X_1 and X_2 are selected from F and CF_3 ;

bisvinyloxymethanes having structure (III):



wherein X^1 and X^2 , equal to or different from each other, are F, Cl; X^3 and X^4 , equal to or different from each other, are F or CF_3 ;

dienes having structure (IV);



wherein $n = 1 - 5$;

[or]

- B) homopolymers of monomers having structure (I) or (III) or (IV);
- C) copolymers of monomers having structure (I) or (III) or (IV).

Mentioned in Remarks.

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Oct. 1987

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pop'ū-lāte, *v.i.*; populated, *pt.*, *pp.*; populating, *ppr.* [from *ML. populatus*, *pp.* of *populare*, to populate, from *L. populus*, the people.]

1. to be or become the inhabitants of; to inhabit.
2. to people; to furnish with people or inhabitants, either by natural increase or by immigration or colonization.

pop'ū-lāte, *v.i.* to propagate; to increase. [Obs.]

pop'ū-lā'tion, *n.* [*LL. populatio*.]

1. all the people in a country, region, etc.
2. the number of these.
3. a (specified) part of the people in a given area; as, the Japanese population of Hawaii.
4. a populating or being populated.
5. in biology, all the organisms living in a given area.
6. in statistics, a group of items or individuals.

population explosion, the very great and continuing increase in human population in modern times.

pop'ū-lā-tōr, *n.* one who populates or peoples.

pop'ū-lin, *n.* [*L. populus*, *poplar*, and *-in*.] a crystallizable substance found in the bark, root, and leaves of the *Populus tremula*, or aspen, along with salicin.

Pop'ū-lism, *n.* [from *L. populus*, the people; and *-ism*.]

1. the theory and policies of Populists.
2. the Populistic movement.

Pop'ū-list, *n.* one belonging to the People's party.

Pop'ū-list, *a.* same as *Populistic*.

Pop'ū-list'ic, *a.* 1. of Populists or their views.

2. having to do with the People's party.

pop'ū-lous, *a.* [*L. populosus*.] full of people; thickly populated.

pop'ū-lous-ly, *adv.* with many inhabitants in proportion to the extent of country.

pop'ū-lous-ness, *n.* the state of being populous.

Pop'ū-lus, *n.* [*L. poplar*.] a genus of trees which includes the common poplar. *Populus alba* is the European white poplar.

por'bea'gle, *n.* [from *Corn. dial.*] any shark of the genus *Lamna*, especially *Lamna cornubica*, found in northern seas; it is large and fierce and brings forth living young rather than eggs.

por'cāte, **por'cā-ted**, *a.* [*L. porca*, a ridge.] ridged; formed in ridges.

por'ce-lain (-lin), *n.* [so called from its resemblance to the Venus shell, which is, in *It.*, *porcellana*, from *porcella*, a little pig, the upper surface of the shell resembling the curve of a pig's back.]

1. a fine, white, translucent, hard earthenware with a transparent glaze; china.
2. porcelain dishes or ornaments, collectively.

por'ce-lain, *a.* made of porcelain.

por'ce-lain crab, a crab having a very smooth, polished shell, as *Porcellana platycheles*, the broad-clawed species.

por'ce-lain'ized, *a.* altered by heating so as to resemble porcelain; in geology, metamorphosed so as to resemble white earthenware, as clays, shales, etc.

por'ce-lain jas'pēr, porcelainite.

por'ce-lā'nē-ous, **por'cel-lā'nē-ous**, *a.* of or resembling porcelain.

por'ce-lā-nite, **por'cel-lā-nite**, *n.* a semi-vitrified clay or shale, somewhat resembling jasper.

por'ce-lā-nou, **por'cel-lā-nous**, *a.* same as *porcelaneous*.

porch, *n.* [*ME. and OFr. porche*, from *L. porticus*, from *porta*, a gate, entrance, or passage.]

1. a covered entrance to a building, usually projecting from the wall and having a separate roof.
2. an open or enclosed gallery or room on the outside of a building; a veranda.
3. a portico; a covered walk. [Obs.]

the Porch; a portico in Athens where the Stoic philosopher Zeno taught his disciples.

porch climb'er (klīm'), a burglar who gains entrance to a house by climbing the porch. [Slang.]

por'cine, *a.* [*L. porcinus*, from *porcus*, hog.] of or like pigs or hogs.

por'cū-pine, *n.*; *pl.* **por'cū-pines** or **por'cū-pin**, [*ME. porkepyn*, *pork despyne*; *OFr. porc espin*, the spinous hog, or spine hog; *L. porcus*, and *spina*, a spine or thorn.] any of a number of related gnawing animals; specifically, (a) the old-world porcupine,

Hystrix cristata, of the family *Hystriidae*, bearing long, stiff, erectile spines sometimes a foot in length; (b) the North American porcupine, of the family *Erethizontidae*, which is armed with short, sharp quills or spines that may be easily detached from the body. The two species of this porcupine are *Erethizon dorsatus* of the eastern part of the United States and Canada, and *Erethizon epixanthus* of the West.



PORCUPINE

por'cū-pine ant'eat'er, an echidna, an ant-eating mammal resembling a porcupine.

por'cū-pine crab, a Japanese crab having long spines on its carapace and limbs; the *Lithodes hystrix*.

por'cū-pine fish, a fish of the tropical seas, *Diodon hystrix*, which is covered with spines or prickles capable of being erected by its inflating the body; also, any fish with similarly erectile spines.

por'cū-pine grass, the common prairie grass, *Stipa spartea*, of the United States.

por'cū-pine wood, the outer wood of the coconut palm, which, when cut horizontally, presents markings resembling porcupine quills.

pore, *n.* [*ME. pore*, *poor*; *L. porus*; *Gr. poros*, a passage, a pore, from *perān*, to pierce.]

1. originally, a passage; a channel.
2. a tiny opening, usually microscopic, as in plant leaves, skin, etc., through which fluids may be absorbed or discharged.
3. a similar opening in rock or other substances.

pore, *v.i.*; **pored**, *pt.*, *pp.*; **poring**, *ppr.* [*ME. poren*, *pouren*.]

1. to gaze intently or steadily.
2. to look searchingly; to read carefully; to study minutely (with over); as, he *pored over* the book.
3. to think deeply and thoroughly; to ponder; meditate (with on, upon, or over); as, he *pored on* the wonders of science.

por'er, *n.* one who pores.

por'gee, *n.* same as *porgy*.

por'gy (or -ji), *n.*; *pl.* **por'gies** or **por'gy**, [*prob. var. of pogy*.] any of a large number of salt-water food fishes having spiny fins and a wide body covered with large scales.

Pō-rif'e-rā, *n.pl.* [*pore*, and *L. ferre*, to bear.] in zoology, a phylum of invertebrates which includes sponges.

pō-rif'er-ān, *n.* any of the *Porifera*.

pō-rif'er-ous, *a.* 1. having pores.

2. in zoology, of or related to the *Porifera*.

pō-rif'orm, *a.* [*L. porus*, pore, and *form*.] resembling a pore.

pō-rif'ness, *n.* the state of being porous, or having numerous pores.

pō-ris'm, [*ME. porysme*; *ML. porisma*; *Gr. porisma*, lit., a thing brought, from *porizein*, to bring.] in ancient mathematics, a geometrical proposition variously defined; specifically, (a) a proposition deduced from some other demonstrated proposition; a corollary; (b) a proposition that uncovers the possibility of finding such conditions as to make a specific problem capable of innumerable solutions.

pō-ris-mat'ic, *a.* pertaining to a porism; seeking to determine by what means and in how many ways a problem may be solved.

pō-ris-mat'ic-āl, *a.* porismatic.

pō-rīte, *n.* a coral of the family *Poritidae*, or of the genus *Porites*.

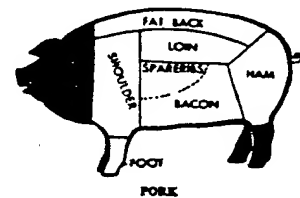
Pō-rī'tēg, *n.* [*LL.*, from *L. porus*, pore.]

1. in zoology, a genus of perforate madreporian corals, having small twelve-rayed calicles and a very porous structure.
2. a genus of millepores.

Pō-rīt'i-dae, *n.pl.* a family of corals of which *Porites* is the type genus.

pork, *n.* [*ME. and OFr. porc*; *L. porcus*, a pig.] 1. originally, a pig or hog.

2. the flesh of a pig or hog, used, fresh, cured, as food.



3. money, position, etc. received from the government through political patronage. [Slang.]

pork bar'el, government appropriations for political patronage, as for local improvement to please legislators' constituents. [Slang.]

pork'er, *n.* a hog, especially a young one fattened for use as food.

pork'et, *n.* a young hog. [Rare.]

pork'fish, *n.*; *pl.* **pork'fish-es** or **pork'fish**, black grunt, *Anisotremus virginicus*, with yellow stripes, of the West Indies.

pork'i-ness, *n.* the state or quality of being porky.

pork'ling, *n.* a young pig.

pork pie, 1. a meat pie made of chopped pork, usually eaten cold.

2. a soft hat with a round, flat crown, worn by men; now often *porkpie*.

pork'pie, *n.* same as *pork pie*, sense 2.

pork'y, *a.*; *comp.* **porkier**; *superl.* **porkiest**, 1. of or like pork.

2. fat, as though overfed.

3. saucy, cocky, presumptuous, impertinent, or the like. [Slang.]

por'nō, *n.* pornography. [Slang.]

por'nō, *a.* pornographic. [Slang.]

por-noç'ra-cy, *n.* [*Gr. pornē*, prostitute, and *kratein*, to rule.] government by prostitutes; domination, sway, or influence of profligate women; specifically, the government of Rome in the early part of the tenth century.

por-nō-graph'ic, *a.* of, or having the nature of, pornography; obscene.

por-nog'ra-phy, *n.* [*Gr. pornē*, prostitute, and *graphein*, to write.]

1. originally, a description of prostitutes and their trade.
2. writings, pictures, etc. intended to arouse sexual desire.
3. the production of such writings, pictures, etc.

por-o-mēr'ic, *n.* [arbitrary coinage, prob. from *porous*, and *polymeric*.] a synthetic, leather-like, porous material, often coated or impregnated with a polymer.

pō-rō-phyl'lous, *a.* [*Gr. poros*, pore, and *phylon*, leaf.] in botany, having leaves covered with transparent points or dots.

Pō-rō'sā, *n.pl.* same as *Perforata*.

pō-rōse', *a.* [*LL. porosus*, full of pores.]

1. porous.
2. of or pertaining to the *Porosa*.

pō-ro-si'ty, *n.*; *pl.* **pō-ro-si'ties**, [*ME. poros-ice*; *ML. porositas*, from *porosus*, from *L. porus*, a pore.]

1. the quality or state of being porous.
2. the ratio of the volume of a material's pores to that of its solid content.
3. anything porous.
4. a pore.

pō-rot'ic, *n.* [*Gr. pōros*, a callus.] any medicine which assists in the formation of callus.

pō'rous, *a.* [from *pore*.] full of pores, or tiny holes through which fluids, air, or light may pass; as, a *porous* skin; *porous* wood; *porous* earth.

pō'rous-ly, *adv.* in a porous manner.

pō'rous-ness, *n.* the quality or state of having pores; porosity; as, the *porousness* of the skin of an animal, or of wood.

por'pen-tine, *n.* porcupine. [Obs.]

por-phy-rāc'eous, *a.* same as *porphyritic*.

por'phyre, *n.* porphyry. [Obs.]

por'phy-rin, *n.* [from *hematoporphyryn*, from *hemato-*, and *Gr. porphyrā*, purple, purple product of hemoglobin decomposition.]

any of a group of pyrrole derivatives of hemoglobin and chlorophyll, containing no iron or magnesium.

por'phy-rin (-rēn), *n.* a chemical substance, colorless and uncrystallized, obtained from the bark of an Australian tree, *Alstonia constricta*.